KEENLEYSIDE POWER PLANT PROJECT
WILDLIFE STUDIES

PREPARED FOR B.C. HYDRO
by
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KEENLEYSIDE POWERPLANT PROJECT: WILDLIFE STUDIES

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This impact assessment is based on the "Keenleyside Powerplant Project Engineering Description" prepared in November 1982. Since that time, ongoing planning and design studies have resulted in some changes that would affect the project description. The principal changes are as follows:

- In-service date has changed from 1992 to 1994 and the optional in-service date of 1990 is no longer being considered.

- Installed capacity has changed from 210 MW to 180 MW with corresponding changes to powerhouse design.

The above changes have been incorporated in the report only where they would affect the results of the impact assessment.

STUDY TEAM

This report was prepared for B.C. Hydro as the wildlife component of a series of environmental studies which will collectively form the basis of an Environmental Impact Assessment of the Keenleyside Powerplant Project.

The report was prepared by Beak Consultants Limited, Vancouver, and the study team was composed of the following: I. Robertson - Project Manager, Furbearers, Birds; R. Moody and A.I. Moody - Big Game Animals; D. Day - Drafting and S. Flaata - Word Processing.

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G. Worobey	Fur Trapper, Castlegar

1.0 SUMMARY

The proposed Keenleyside Powerhouse Project has been evaluated to determine the magnitude of impacts on wildlife resources of the study area. Results of the Murphy Creek wildlife studies (BEAK, 1983) as well as winter 1982 surveys were used to address the concerns in the study area. The results are summarized below.

1. Mule deer and white-tailed deer are the most common ungulates in the study area. Two groups of elk were transplanted into the region in 1972 and are now commonly found mainly above the upper limit of the study area (500 m elevation).

2. Good winter range is restricted primarily to the south-facing slopes on the north side of Lower Arrow Lake.

3. Numbers of aquatic furbearers in the study area are low, based on distribution of tapping effort and harvest.

4. Aquatic bird numbers are low. Comparisons with nearby reaches of the Columbia River indicated the annual drawdown in the Arrow Lakes Reservoir is a contributing factor to these low numbers.

5. The impacts of the Keenleyside Powerplant construction are expected to be localized and minor. Some temporary disruption of ungulates and terrestrial birds may occur in the vicinity of the proposed powerplant.

6. Excavation of the borrow areas could result in temporary removal of ungulate habitat. This habitat could be regained and enhanced by future reclamation/revegetation procedures.

7. The maximum height of the reservoir is expected to remain the same, therefore no lowland winter habitat will be lost. The magnitude of the annual drawdown may be reduced by about one third (7 m) under Regime 2. Though this is a change in the right direction, there is no evidence to predict measurable improvement to wildlife or their habitat.

2.0 INTRODUCTION

The Hugh Keenleyside Dam, completed in 1968, was intended primarily to satisfy the terms of the Columbia River Treaty in providing storage to lessen downstream flooding and to increase generation potential in the United States. Although generating facilities were considered at the time of dam construction, the decision was to not include them in the original construction. Along with the studies of the Murphy Creek Project (B.C. Hydro, 1982), a prefeasibility study of Keenleyside power generation was undertaken by B.C. Hydro to optimize both projects.

Beak Consultants Limited (BEAK) was requested by B.C. Hydro to undertake wildlife studies of all lands below 500 m elevation within 10 km of the Keenleyside Dam. This area consists of the Lower Arrow Lake from Shields to Hugh Keenleyside Dam and continues in the Murphy Creek study area to Castlegar (Figure 1). The Keenleyside studies were to complement the Murphy Creek wildlife studies (BEAK, 1983) and therefore much of the baseline data presented in the Murphy Creek wildlife report are not repeated here.

The specific objectives of the Keenleyside study were to:

1. provide an inventory of wildlife resources within the study area;
2. evaluate and identify impacts resulting from the proposed project; and
3. suggest mitigation measures designed to avoid or minimize negative impacts.

As in the Murphy Creek study, the upper study area limit of 500 m was arbitrary. Consequently the survey extended above the 500 m contour particularly in the vicinity of the dam (where new construction would approach the 500 m contour) and the Balfour borrow pit (Area No. 9) which lies above the 500 m contour (Figure 1).

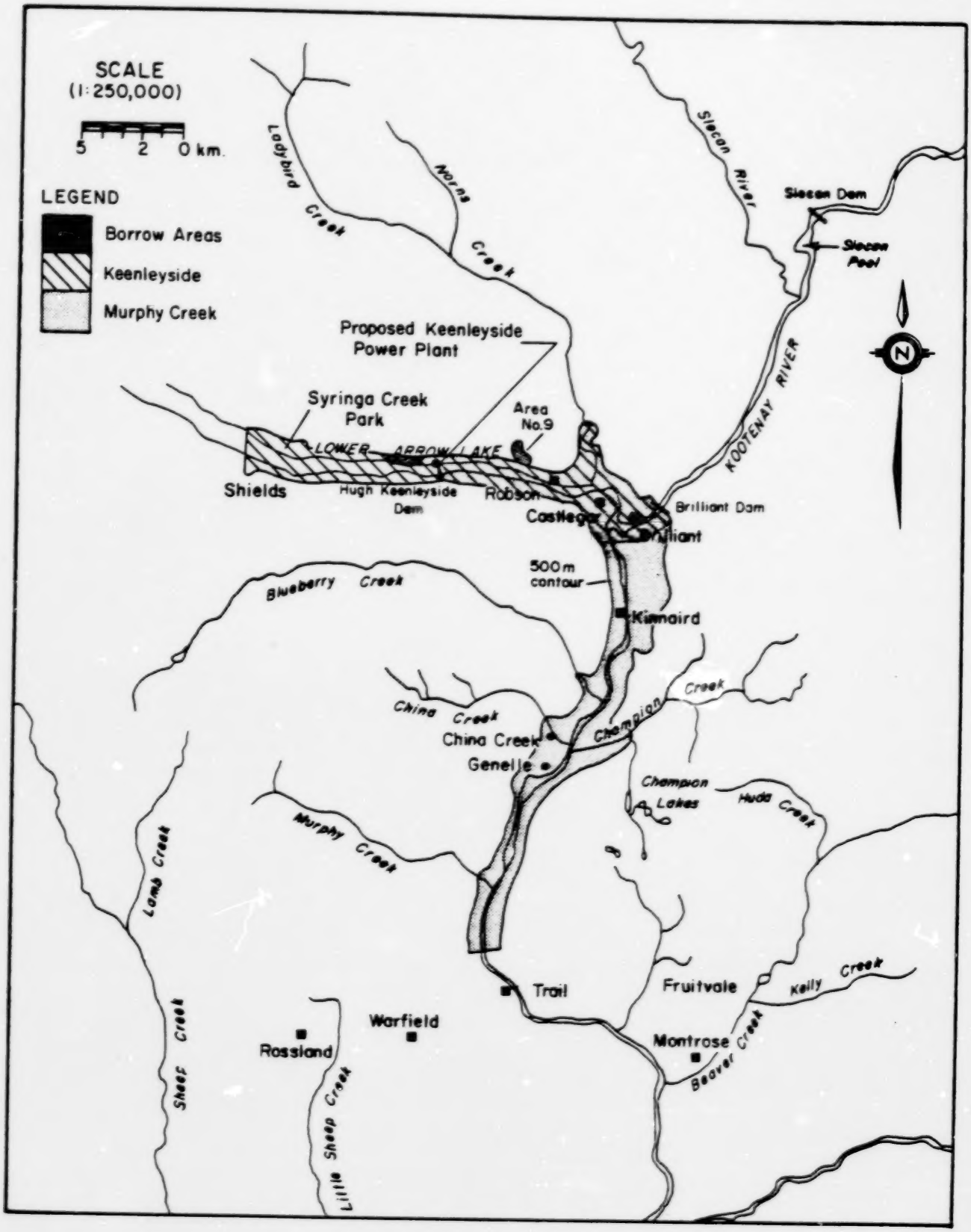

FIGURE 1 : The Study Area.

3.0 STUDY DESIGN

During the course of the Murphy Creek wildlife studies, big game surveys were flown in the Columbia River Valley between the Hugh Keenleyside Dam and Trail on the following dates:

19 July 1980
17 January 1981
16 February 1981
3 January 1982
18 March 1982

To complement these surveys, a wildlife survey was flown in the Keenleyside project area on 20 March 1982. The surveys were flown in a Bell 206 (Jet Ranger) at an elevation of approximately 65 m and a ground speed of 65-80 km/hr. One observer on each side of the helicopter recorded observations on topographic charts and on tape.

Two of the browse pellet group transects surveyed in October 1980 were situated within the Keenleyside study area, specifically the Robson Ridge and Keenleyside transects. The latter was very close to the location of the proposed power plant. Due to the timing of this study and the availability of previous ground survey data, it was decided to limit the field work of this study to one late winter survey. Late winter is a critical period for deer survival and if any important areas of low elevation winter habitat occurred within the study area they should have been identifiable during the course of this survey. The B.C. Fish and Wildlife Branch also provided us with winter survey data for 1982 in the Keenelyside study area.

As part of the wildlife studies associated with the Murphy Creek project, data were collected on furbearers, waterfowl, upland game and passerine birds. These data are the basis for considering the Keenleyside Powerplant Project and its impacts.

Surveys for aquatic birds were flown 30 May and 10 October 1980, and 26 March 1981. The surveys utilized a Bell 206 (Jet Ranger) and followed the Columbia

River upstream past the Hugh Keenleyside Dam as far as Deer Park on the Arrow Lakes Reservoir. (Another part of the same survey route continued up the Kootenay River as far as Slocan Pool (BEAK, 1983).) Ground speed during these surveys was 65-75 km/h, except when large aggregations were encountered. At such times the helicopter circled until specific identifications and accurate counts could be completed.

Upland game birds were surveyed in mid-October 1980 using Brittany spaniels along browse and pellet group survey transects (BEAK, 1983). The Keenleyside transect located on the north side of the Columbia River between the Hugh Keenleyside Dam and the Village of Robson is pertinent to this study.

4.0 INVENTORY OF WILDLIFE RESOURCES

4.1 Big Game Animals

Mule deer[1], white-tailed deer and elk are the most common species of big game animals in the Keenleyside study area. Black bear and cougar also occur in the area, the former being much more numerous. Moose are infrequent visitors to the study area. Mountain goats occur in low numbers in isolated pockets of suitable habitat.

An outline of the habitat requirements of deer, based upon available literature for similar areas is available in the Murphy Creek report (BEAK, 1983). It is summarized below. For the Keenleyside study, earlier field studies conducted in the overlapping portion of the Murphy Creek study area have been used (Figure 1). In addition to this, we have used information from the 1982 mid-winter surveys by the B.C. Fish and Wildlife Branch, and BEAK's late winter survey have also been used. Information acquired from locally knowledgeable individuals, B.C. Fish and Wildlife Branch personnel and unpublished reports have also aided in a general understanding of the study area.

In general, the most critical period for ungulate survival is late winter. In all seasons but winter deer are specialists, selecting their forage according to taste preferences. A list of favored browse species is presented in the Murphy Creek report (BEAK, 1983). However, during winter when food availability is restricted, deer become generalists, feeding on whatever is available. Elk tend to be grazers in spring and summer, and browsers in winter (Boyd, 1978), and can compete for food with deer. Deer winter habitats are concentrated on south and west aspects due to their warmth, lower snowpack and greater shrub component (Loveless, 1967). White-tailed deer tend to remain in lower elevation sites year-round but will disperse from their late winter "yards" as soon as possible. Mule deer favor winter range with steep south and west facing slopes from valley bottom to elevations of approximately 1,220 m (CLI 1971).

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[1] Common and Scientific names are listed in Appendix 1.

Snow depths in excess of 50 cm restrict deer movements (Loveless, 1967) and greater than 75 cm restrict elk movements. Therefore deer, and to a lesser extent elk, move to low elevation, lower snow conditions in winter. However, because of their greater mobility in snow, elk tend to remain at higher elevations than do deer. An examination of snow records (for snow remaining on ground at the end of the month) for Castlegar reveals that during the past 10 years there has only been one period (Feburary 1975) during which elk mobility would have been restricted by snow depth. Surveys in the vicinity of the study area have always found elk at elevations above 500 m. As soon as snow conditions permit, deer (especially mule deer) will disperse to generally higher elevations in search of more palatable forage (Harestad, 1979).

The original CLI map for ungulates (82 F) rates the area between Castlegar and Tulip Creek as Class 3 winter range, which is restricted by snow depth and rooting depth (closeness of bedrock). The adjacent Cayuse Creek valley to the northwest (Deer Park) beyond the Keenleyside study area is rated as 2 WQ (Class 2 winter range limited by snow). This is among the best winter range available in the Nelson area. This point has been underlined by supplementary habitat mapping of the Robson to Deer Park area (Warner et al. 1974). The rating for lands under 1,220 m (4000 ft.) has been upgraded to 70% Class 1 and 30% Class 2 winter range for deer and elk (G. Woods, B.C. Fish & Wildlife Branch, pers. comm.). The south-facing bluffs and rocky outcrops on the north side of Arrow Lake between Keenleyside and Tulip Creek appear to have suitable winter habitats for mule deer in particular. However, we did not find any indication of deer use (tracks, beds, etc.) during our survey in March 1982. Warner et al. (1974) did not find any pellet groups in the area, but they did find evidence of browsing. The south side of the study area (i.e. north-facing) is rated Class 3 winter range for deer. It appears that the best winter range lies to the west of the present study area.

The vegetation on the north side of Lower Arrow Lake reflects a moisture gradient between Robson and Deer Park. In general, Deer Park receives up to 50% less annual precipitation than does Robson. From Robson west the forest changes from a predominantly Douglas fir forest to open bluffs, dominated by ponderosa pine. The study area is also characterized by a moisture deficit during the summer. In

combination with the very well drained, coarse soils, this would result in a lack of palatable forage for ungulates in the summer period. An exception to this would be seepage sites on benches where the deer remain until these areas dry up in mid-July to late August (Warner et al., 1974).

Survey results for the Keenleyside study area are presented in Table 1. Three different surveys are reflected in these data. The earliest survey revealed the greatest number of animals. Generally the Fish and Wildlife surveys were flown well above the study area at approximately 700 m. During the January survey, a total of 21 elk, 16 mule deer and 8 white-tailed deer were found between Sentinel Mountain and Tulip Creek. The late winter survey revealed 21 elk, no mule deer and 2 white-tailed deer. The March survey by BEAK found only 14 elk (Figure 2).

The animals did not appear to be restricted to a limited winter area in 1982. Although the winter was characterized by heavy early and mid-winter snowfalls, temperatures were average and there was an early snowmelt. This may explain why surveys of the Murphy Creek study area revealed greater concentrations of deer in January than in March. This means the animals were occurring at low elevations in January, then dispersing in March with the snow melt.

The south side of Lower Arrow Lake (north-facing slopes) appeared to have very little wildlife use except for the high bluffs (outside the study boundaries) which provided good mountain goat range. Most of the forest in this area was dense and had a relatively heavy snowpack. Although a few deer tracks were sighted, in general they were isolated sets and no concentrations appeared.

Warner et al. (1974) made the observation that dense forests were used for cover on the north side of Arrow Lakes Reservoir when there were sparsely vegetated areas or clearings nearby for foraging. It is now felt that the Deer Park area is deteriorating in terms of wildlife values due to the succession taking place in former rich browse production areas (G. Woods, B.C. Fish and Wildlife Branch, pers. comm.). Great improvement could be made by selective logging or burning. It is likely that the forest on the south side is too dense and has too little browse to support a good deer population. Also because of the northern exposure, snow cover tends to remain longer into the spring.

TABLE 1: Winter Ungulate Survey Results, 1982

Location	Elk	Mule Deer	White-tailed Deer	Coyote
15 January 1982[1]				
Sentinel Mtn. to Robson	18	-	-	-
Robson to Keenleyside	1	-	3	-
Keenleyside to Syringa Cr.	2	16	-	-
Syringa Cr. to Tulip Cr.	-	-	5	-
Tulip Cr. to Cayuse Cr.	-	3	-	-
Cayuse Cr. to Deer Park	19	7	-	-
	40	26	8	0
2 February 1982[2]				
Sentinel Mtn. to Robson	9	-	-	-
Robson to Keenleyside	12	-	2	-
Keenleyside to Syringa Cr.	-	-	-	1
Syringa Cr. to Tulip Cr.	-	-	-	-
Tulip Cr. to Cayuse Cr.	15	5	-	-
Cayuse Cr. to Deer Park	-	7	2	-
	36	12	4	1
20 March 1982[3]				
Sentinel Mtn. to Robson	14	-	-	-
Robson to Keenleyside	-	-	-	-
Keenleyside to Syringa Cr.	-	-	-	-
Syringa Cr. to Tulip Cr.	-	-	-	-
Tulip Cr. to Cayuse Cr.	-	-	-	-
Cayuse Cr. to Deer Park	-	-	-	-
	14	0	0	0

1 Surveyed by B.C. Fish & Wildlife Branch - G. Woods, G. Fox & P. Stour
2 Surveyed by B.C. Fish & Wildlife Branch - G. Woods, J. Gwilliam, W. Campbell
3. Surveyed by Beak Consutlants Limited - R. Moody & A. Moody

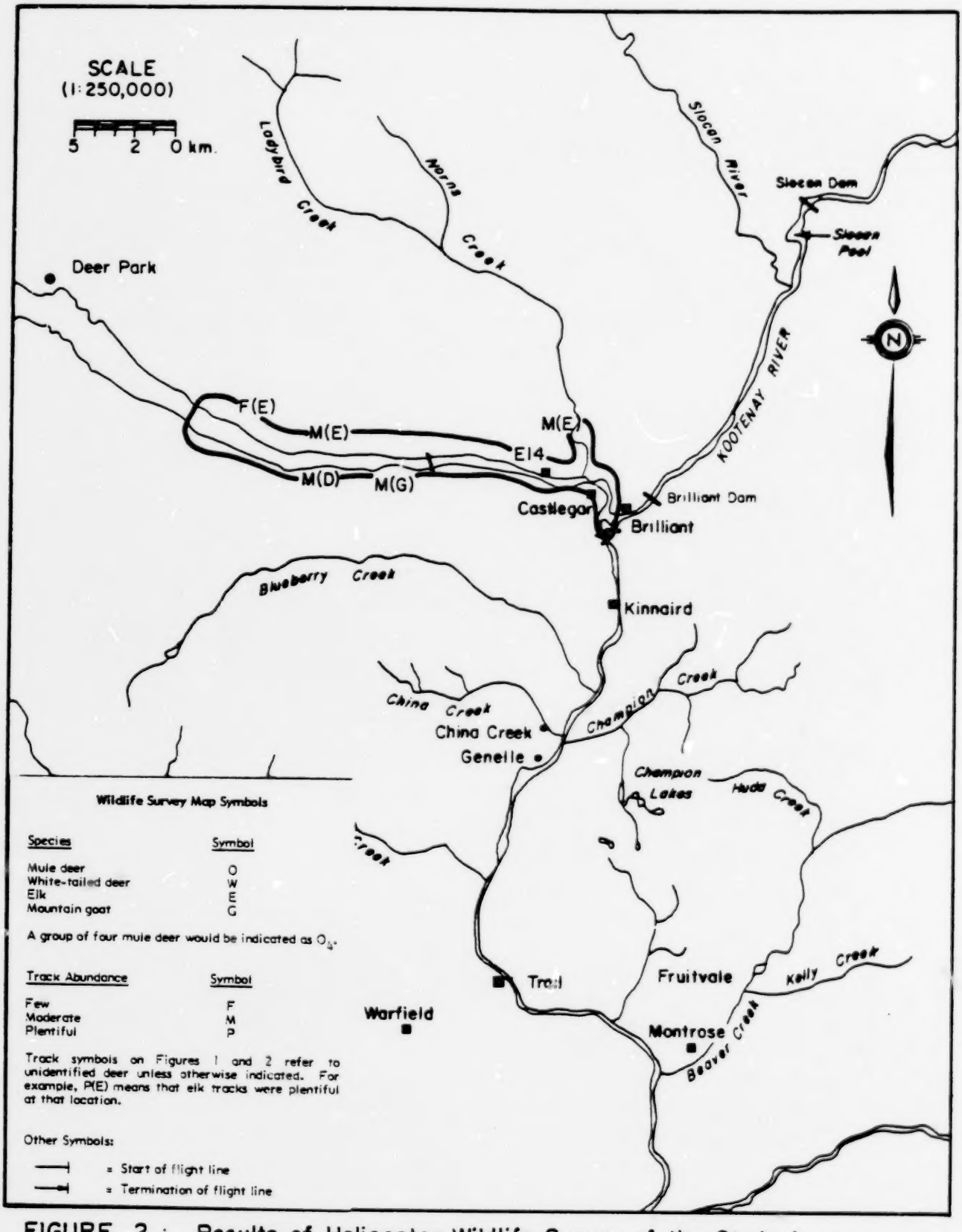

FIGURE 2 : Results of Helicopter Wildlife Survey of the Study Area, March 20, 1982.

4.2 Furbearers

There are two traplines situated along Lower Arrow Lake near the Hugh Keenleyside Dam. Trapline D extends from Robson along the north shore of the Columbia River and Arrow Lake and includes all of the northern study area. Trapline E extends along the south shore west from Castlegar past Shields and includes all of the southern study area. The species harvested by these traplines are mostly terrestrial (Table 2). Aquatic furbearers are a small proportion of the harvest.

Beaver and otter are known to occur in small numbers along the Lower Arrow Lake and Columbia River immediately downstream of the Hugh Keenleyside Dam (G. Worobey, F. Salekin, pers. comm.). It is the apparent small numbers of aquatic furbearers which explains the concentration of the trapping effort in higher elevation sub-alpine forests where terrestrial species are taken (red squirrel, weasel, marten, etc.).

Beaver habitat has several requirements, of which two are germane to this study. The first is water level stability. A fluctuating waterbody such as Arrow Lakes Reservoir or Columbia River tends to prevent the successful establishment of beaver lodges. The second is cover. The wide unvegetated zone at the lower end of Arrow Lakes Reservoir creates a cover-free, exposed area which makes animals vulnerable to predation. The absence of these required habitat characteristics provides some explanation for the low harvest of aquatic furbearers.

4.3 Birds

Aquatic Birds

Numbers of birds in the Columbia River system were found to be low at all survey periods (BEAK, 1983). The areas immediately adjacent to the proposed Hugh Keenleyside power station were not an exception (Table 3). Several points can be made to characterize this stretch of river.

TABLE 2: Furbearer Trap-Harvest Records for the Two Registered Traplines near the Proposed Keenleyside Power-plant Project

	Trapline D							Trapline E								
	Year of Record															
Furbearer	79	78	77	76	73	72	70	79	78	77	76	74	73	70	Total	Annual Average
American Beaver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.00
Bobcat	2	1	-	6	4	-	6	-	-	-	4	-	-	-	23	1.64
Coyote	1	1	-	-	-	-	1	-	2	-	-	3	-	-	8	0.57
Lynx	-	1	-	-	-	2	-	7	3	5	6	1	1	6	32	2.29
Marten	5	7	4	-	-	-	-	4	5	2	-	3	4	-	34	2.43
Mink	-	-	-	-	-	-	-	1	-	-	1	1	-	-	3	0.21
Muskrat	-	-	-	-	-	-	-	6	-	-	10	-	-	-	16	1.14
Otter	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.07
Raccoon	-	-	-	-	-	-	-	-	-	-	1	2	-	-	3	0.21
Red Squirrel	36	1	9	4	2	1	30	35	5	32	25	4	6	2	192	13.71
Weasel	8	4	13	-	-	-	6	6	1	12	6	3	2	1	62	4.43
Red Fox	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.07

TABLE 3: Aerial Surveys of Aquatic Birds Near the Hugh Keenleyside Dam

	Columbia River: confluence with Kootenay River to Hugh Keenleyside Dam*		Arrow Lakes Reservoir: Hugh Keenleyside Dam to Deer Park		
	30 May 1980	26 Mar. 1981	30 May 1980	10 Oct. 1980	26 Mar. 1981
Red-necked Grebe	-	-	2	-	-
Horned Grebe	-	-	-	-	32
Eared Grebe	-	-	-	2	-
Western Grebe	-	-	-	28	-
Canada Goose	10	-	-	-	-
Mallard	37	20	1	71	8
Pintail	-	-	-	-	5
Blue-winged Teal	8	-	20	-	-
American Wigeon	-	7	-	13	18
Ring-necked Duck	1	-	-	-	-
Canvasback	2	-	-	-	-
Scaup sp.	-	-	-	6	-
Common Goldeneye	-	36	-	-	11
Barrow's Goldeneye	8	-	-	-	-
Bufflehead	-	22	-	12	8
White-winged Scoter	2	-	-	10	-
Common Merganser	13	3	6	10	15
Unidentified Duck	2	-	-	6	3
Killdeer	2	-	5	2	-
Spotted Sandpiper	12	-	10	-	-
Ring-billed Gull	-	-	-	1	-
Bonaparte's Gull	5	-	-	-	-
Unidentified Gull	31	12	1	33	2
Osprey	3	-	3	-	-
TOTAL	136	100	48	194	102

* Records of the 10 October survey do not separate this part of the Columbia River.

Upstream of the dam, utilization of Arrow Lake by birds appears to be very low (BEAK, 1983). A few migrant flocks were spotted on the 10 October and 26 March surveys, but there was little indication of any significant numbers of resident or breeding birds. The only consistent concentration site for a few common mergansers and gulls was on log booms near the dam.

Downstream, the reach of river from the dam to the Columbia-Kootenay confluence attracts consistent numbers of ducks and gulls (BEAK, 1983). Mallards breed in small numbers in the Pass Creek sewage lagoon area and remain throughout the winter (Table 2). Several dozen diving ducks use the area in winter. Though this reach of river compares favorably in waterfowl utilization with nearby stretches of the Columbia River, numbers are very low.

Terrestrial Birds

One pair of osprey nest on pilings beside the B.C. Timber Pulp and Paper mill. This is a traditional nest site which was confirmed during the 30 May 1980 survey.

The upland game bird survey along the Keenleyside transect failed to locate any birds. Based on records of the West Kootenay Naturalists Association, ruffed grouse is the most common upland game bird at the lower elevations. In the area of the gravel pits, blue and spruce grouse may occur, but neither species is considered common (W.M. Merilees, pers. comm.).

5.0 PROJECT IMPACTS

5.1 Classification

In the evaluation of project impacts and their classification, this report follows the same terminology as the companion wildlife study for the Murphy Creek Project (BEAK, 1983). Specific impacts on wildlife were identified as positive or negative, depending on whether the impact tends to increase or decrease growth, survival, reproductive success or general productivity of the affected wildlife population. The magnitude of such impacts are classified as major, moderate, minor or insignificant. Major impacts are those which threaten i) the persistence of a resource or ii) a population of rare/endangered species in a region. A moderate impact would not threaten the persistence of a resource, animal community or population, but might alter its numbers or distribution. An example of a moderate impact would be the loss of shorebird habitat from the proposed Murphy Creek project. Based on comparable reservoir and river inventory studies, the population would persist, but at much lower numbers. An important property of major and moderate impacts is that they are easily detectable. A minor impact may be of equal severity to a moderate impact, but be restricted to a very localized area or be short-term phenomenon. An insignificant impact is one in which the effects of development on a particular population would be difficult to detect.

This impact classification scheme is presented to clarify terms used in this section. As an objective rating scheme it has a number of significant limitations. Environmental impact is a predictive and rather subjective exercise: two elements which give it wide confidence limits. In other words, it tends to be rather imprecise. Moreover, it is a public process in which popular conservation interests and perspectives have some input. For example, the objective classification of a moderate impact to describe deterioration to a shorebird habitat on the Columbia River might underrate impacts were the species to be, for example, Sandhill Crane. In such a case conservation value of cranes might raise the impact to the level of major.

The Keenleyside Powerplant Project and potential changes to the operating regime of the Arrow Lakes Reservoir involve several potential impacts to wildlife. The

project elements considered here are powerplant construction, borrow and spoil areas, and reservoir flucutuation. Potential impacts to deer, aquatic furbearers and birds are considered under these categories.

5.2 Powerplant Construction

The construction of the powerplant and surrounding infrastructure, including the Robson-Broadwater Highway realignment, would involve increased human activity and disturbance created by heavy equipment. It is likely to result in deer tending to avoid the area during this period. However, deer use of the immediate area is low at present. Thus, the impacts though considered negative, are judged to be insignificant under all the categories considered (Table 4).

Impacts on aquatic furbearers are also predicted to be insignificant. This assessment is based on the evidence that their numbers are presently low and that construction related disturbances would be localized.

Aquatic birds are not known to breed in the immediate vicinity of the site, eliminating this as a possible impact. A few birds forage below the dam. During construction of the power plant they may occasionally be disturbed.

The disturbance to terrestrial habitats would be very limited. As a result, little nesting habitat would be lost. Construction activity could reduce nesting immediately adjacent. Collectively these impacts are not significant.

The only species which has been considered rare or endangered is the osprey. A pair nests on pilings beside the BC Timber Ltd. pulp and paper mill. This is some 2 km from the construction. Little impact is expected to the breeding ospreys.

5.3 Borrow and Spoil Sites

Borrow material for construction will come from several nearby sites (B.C. hydro, 1982). One of these (Area No. 9) has been used historically as a source of material and occurs in relatively high potential ungulate winter range. The site is disturbed

TABLE 4: Summary of Project Characteristics and Their Related Impacts

	Powerplant Construction	Borrow & Spoil Areas - No Mitigation	Borrow & Spoil Areas Mitigation	Reservoir Operation
Deer:				
Numbers	-1	-2	+1	+1
Distribution	-1	-2	+1	+1
Habitat - winter	-1	-2	+1	+1
Habitat - summer	-1	-1	+1	0
Movements	-1	-1	+1	0
Nonconsumptive Use	-1	-1	+2	0
Consumptive Use	-1	-1	+1	0
Aquatic Furbearers	-1	0	0	+1
Birds:				
Ducks	-1	0	+1	+1
Mergansers	-1	0	0	+1
Upland Game	-1	-1	+1	0
Raptors	-1	-1	+1	0
Nonconsumptive Use	-1	-1	+2	+1
Consumptive Use	-1	-1	+1	+1

0 - no effect

1 - insignificant

2 - minor

from earlier use. However, its renewed use and the distrubance along the 5 km haul road represents, at least during the construction period, a negative impact though at a minor level (Table 4). This impact would largely terminate with the completion of the project. If this area is simply abandoned there will be slow recovery through natural revegetation. However, mitigation through a program of landscaping and revegetation would represent a positive impact, even though the extent of the benefit would probably not be significant.

The other borrow and spoil areas, planned for the land immediately adjacent to the Arrow Lakes Reservoir, receive little wildlife use at present. Impacts here would be insignificant. Because revegetation and landscaping are planned for these low elevation areas there would be some positive impacts. However, this report does not recommend that any special efforts be made to attract deer. Most of these areas are small, and south of the road. Hypothetically, attractive parks south of the road could lead to increased road kills.

5.4 Reservoir Operation

Under present operating conditions (Regime 1) the Arrow Lakes Reservoir level fluctuates from a mean high of approximately 440 m (July - November), down to approximately 421 m (March). Following completion of the Keenleyside Powerplant Project the operating regime likely would change (B.C. Hydro, 1982). Hypothetical future operations (Regime 2) would be characterized by a mean maximum level of 440 m (July - November) lowering to a mean lower level of about 428 m (April). Although there is a slight change in the timing of these events, the main difference is that the magnitude of the drawdown would be reduced by approximately 7 m.

The impact of such an operational change to wildlife would be insignificant. The characteristics of fluctuating reservoirs which make them unattractive to wildlife persist under the proposed Regime 2. Most notably the elimination of any potential to establish littoral and shoreline vegetation remains. However, reduced drawdown would be positive rather than a negative change.

6.0 MITIGATION MEASURES

The most significant wildlife related impact from the Keenleyside Powerplant Project appears to be renewed use of the upper borrow site (Area No. 9), and the associated 5 km haul. These impacts are largely temporary and in the borrow site a revegetation program could improve habitat once construction activities are completed.

Impacts on furbearers and birds are negligible, and no mitigation measures are recommended.

7.0 REFERENCES

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APPENDIX 1
SCIENTIFIC AND COMMON NAMES

APPENDIX: Common and Scientific Names of Animals Identified in the Text

Big Game Animals

Black Bear	*Ursus americanus*
Cougar	*Felis concolor*
Elk	*Cervus canadensis*
Mule Deer	*Odocoileus hemionus*
White-tailed Deer	*Odocoileus virginianus*
Moose	*Alces alces*
Mountain Goat	*Oreamnos americanus*

Furbearers

American Beaver	*Castor canadensis*
Bobcat	*Lynx rufus*
Coyote	*Canis latrans*
Lynx	*Lynx lynx*
Marten	*Martes americana*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Otter	*Lontra canadensis*
Raccoon	*Procyon lotor*
Red Squirrel	*Tamiasciurus hudsonicus*
Weasel (ermine)	*Mustela erminea*
Red Fox	*Vulpes vulpes*

APPENDIX Cont'd: Common and Scientific Names of Animals Identified in the Text

Birds

Red-necked Grebe	*Podiceps grisegena*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps caspicus*
Western Grebe	*Aechmorphorus occidentalis*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
American Wigeon	*Anas americana*
Ring-necked Duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
White-winged Scoter	*Melanitta deglandi*
Common Merganser	*Mergus merganser*
Osprey	*Pandion haliaetus*
Blue Grouse	*Dendragapus obscurus*
Franklin's (Spruce) Grouse	*Canachites canadensis*
Ruffed Grouse	*Bonasa umbellus*
Sandhill Crane	*Grus canadensis*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Ring-billed Gull	*Larus delawarensis*
Bonaparte's Gull	*Larus philadelphia*

APPENDIX 2

TERMS OF REFERENCE

3 February 1982

KEENLEYSIDE POWER GENERATION

Terms of Reference
ENVIRONMENTAL STUDIES

1.0 INTRODUCTION

Prior to signing the Columbia Treaty in 1961 and its ratification in 1964, numerous studies were made of the hydroelectric development of the Columbia River in Canada. The Treaty between the United States and Canada led to the construction of Mica and Hugh Keenleyside projects on the Columbia River in Canada. The Revelstoke project on the Columbia, now under construction, is not a Treaty project.

Keenleyside dam was constructed at the outlet of Lower Arrow Lake near Castlegar, above the confluence of the Kootenay River. The project, completed in 1968, was for the purpose of water storage and contained no power generation facilities.

Since 1977, B.C. Hydro has been studying the Murphy Creek project, which would be located on the Columbia River, 35 km downstream of Keenleyside dam. Three reservoir elevations were studied; the lowest level (424 m) would allow the installation of a powerhouse at Keenleyside. The Murphy Creek project, if built, would not be a Treaty project.

Environmental information on the proposed Murphy Reservoir has been collected for levels 430 m, 427 m and 424 m. These terms of reference are for detailed environmental studies of the addition of Keenleyside power generation to the Murphy Creek 424 m case. All environmental studies should assume Murphy 424 m and identify any changes or

incremental impacts caused by the Keenleyside project. All discussions should clearly specify the differences between the two scenarios.

The Keenleyside reports are intended to be read in conjunction with the Murphy Creek documents, and therefore should avoid duplication of baseline data wherever possible.

Information on the study area without further hydroelectric development, and on the impacts of Murphy 424 m. is available in existing Murphy Creek environmental reports.

Study objectives, organization, liaison and methodology are the same as described in the Murphy Creek terms of reference.

B.C. Hydro will supply information on project description and schedules, operating regime, and will make available environmental reports on Murphy Creek.

2.0 STUDY AREA

The study area consists of all lands and waters below 500 m elevation within 10 km of Keenleyside dam. The study area for fisheries should include the lower Arrow Reservoir and the future Murphy Creek Reservoir (or the Columbia River as far south as Trail). The study area for socio-economics and resource evaluation should include local communities of the Columbia Valley.

(a) Reporting Procedures

Written reports will be required for all sections of the studies. Five draft reports and 45 final reports will be required. Draft reports will be prepared and submitted for review by B.C. Hydro and, where necessary, by outside experts before they are accepted. All final reports shall be in a form suitable for release to government agencies and the public. Following completion of all

the reports for the sections, B.C. Hydro will prepare an integrated summary report in consultation with the authors of the sections and outside experts, where necessary.

(b) Studies Schedule

The studies will be undertaken in early 1982. A target schedule showing specific deadlines will be issued for each section.

(c) Studies Sections

The following are guidelines for each of the sections. These guidelines distinguish between inventory and assessment work. Where feasible this distinction should be made in report preparation.

Study sections are:

A Aquatic Resources
B Vegetation, Agriculture and Forestry
C Wildlife
D Heritage Resources
E Socio-economic Resources
F Recreation
G Land Use
H Water Use
I Resource Atlas
J Resource Evaluation

SECTION C - WILDLIFE

1.0 OBJECTIVES

1. To extend the Murphy Creek Resource Atlas to cover areas potentially affected by the Keenleyside Generation Project.

2. To identify potential impacts of Keenleyside project components on wildlife capability.

2.0 METHODOLOGY

(a) Inventory

Using the same symbols and format as the Murphy Creek wildlife study, map wildlife information within the study area.

(b) Assessment

1. Discuss the effects of Keenleyside construction and operation on wildlife capability.

2. Discuss reclamation of proposed borrow areas in terms of potential benefits (if any) to wildlife.

3. Provide input to the campsite study with respect to impacts of alternative camp locations on wildlife.